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54 **Polyfunctional monomers and process for production thereof.**

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Description(1) Field of the invention

5 The present invention relates to novel polyfunctional monomers useful as starting material for the production of transparent resins.

(2) Description of the Prior Art

10 Transparent resins are generally light in weight and excellent in impact resistance, workability, and mass - productivity in comparison to inorganic glasses, and are used, for example, as vehicle windows, light - covers, indoor notice boards, and skylights.

The synthetic resins mainly used for these applications are, for example, polymethyl methacrylate, polystyrene, and polycarbonate, as well as polydiethylene glycol bisallyl carbonate.

15 The present inventors have investigated the use of transparent resins for parts pertaining to vehicle components such as car windows, and have discovered that polymethyl methacrylate, polystyrene, and polycarbonate have problems in that the surface hardness of these products is low, the resin surface is susceptible to marring, and they are poor in heat resistance. Accordingly, the present inventors have studied intensively to solve these problems.

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SUMMARY OF THE INVENTION

The present invention overcomes the problems and disadvantages of the prior art by providing a new class of monomers from which hard transparent resins can be prepared that are not attended by the
25 disadvantages discussed above.

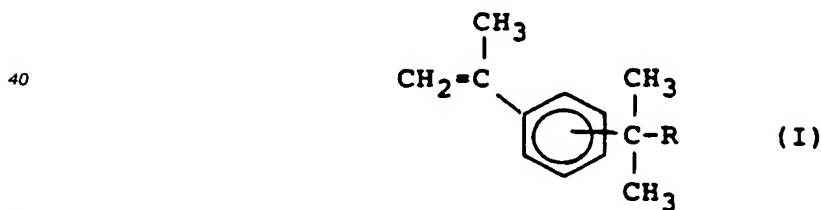
An object of the invention is to provide polyfunctional monomers that can be used as starting materials for production of transparent resins having high transparency, excellent surface hardness, and heat resistance.

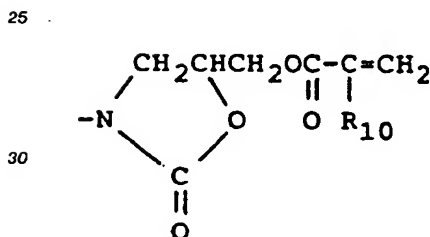
30 A further object of the present invention is to provide polyfunctional monomers whose polymerization conditions are easy to select.

A still further object of the invention is to provide a process for production of the polyfunctional monomers.

Additional objects and advantages of the invention will be apparent from the description that follows, or may be learned by practicing the invention.

35 To achieve the objects and in accordance with the purpose of the invention, as embodied and broadly described herein, the present invention provides a polyfunctional monomer of the general formula (I):





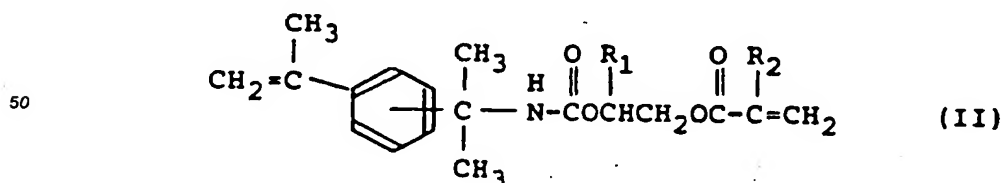
35 and wherein R₁ to R₁₀ each represent hydrogen or a methyl group.

The present invention also provides a process for producing the polyfunctional monomers, comprising reacting 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate with various mono-, di- and tri-acrylate esters, depending on the structure of the desired product.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the present preferred embodiments of the invention.

The first group of the present novel polyfunctional monomers comprises a difunctional monomer
45 represented by the general formula (II):



55 wherein R₁ and R₂ each represent hydrogen or a methyl group.

Specific and non-limiting examples thereof include N-(3-isopropenyl- α,α -dimethylbenzyl)-2-acryloyloxyethyl carbamate, N-(3-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate, N-(4-isopropenyl- α,α -dimethylbenzyl)-2-acryloyloxyethyl carbamate, N-(4-isopropenyl- α

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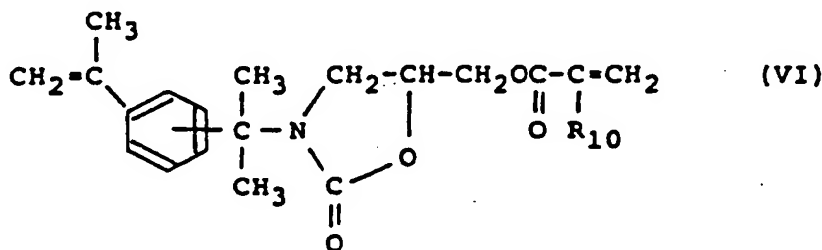
dimethacryloyloxypropan-2-yl carbamate, N-(3-isopropenyl- α,α -dimethylbenzyl)-2,3-diacryloyloxypropan-1-yl carbamate, N-(3-isopropenyl- α,α -dimethylbenzyl)-2-acryloyloxy-3-methacryloyloxypropan-1-yl carbamate, N-(3-isopropenyl- α,α -dimethylbenzyl)-2,3-dimethacryloyloxy-1-yl carbamate, N-(4-isopropenyl- α,α -dimethylbenzyl)-2,3-diacryloyloxypropan-1-yl carbamate, N-(4-isopropenyl- α,α -dimethylbenzyl)-2-acryloyloxy-3-methacryloyloxypropan-1-yl carbamate, N-(4-isopropenyl- α,α -dimethylbenzyl)-2,3-dimethacryloyloxy-1-yl carbamate.

These compounds can be produced by conducting a urethanization reaction of 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate with glycerol diacrylate, glycerol acrylate methacrylate, glycerol dimethacrylate. Optionally, a solvent for the reagents may be or may not be used and optionally the reaction is effected in the presence of a urethanization-promoting catalyst.

The above reaction is carried out such that from about 1 to about 1.2 mol, preferably from about 1 to about 1.5 mol, of glycerol diacrylate, glycerol acrylate methacrylate, glycerol dimethacrylate, is added to about 1 mol of 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate. Preferably, the reaction is carried out in a solvent that will not react with the reagents, such as hexane, benzene, and toluene. The temperature of the reaction medium is kept at from about 25 to about 110 °C, preferably from about 40 to about 65 °C, and optionally a urethanization-promoting catalyst such as dibutyl tin dilaurate is added in an amount of 0.1 to 5 wt. %, preferably 0.5 to 3 wt. %, based on the weight of the isocyanate.

After the reaction is complete, the reaction medium is purified by chromatography to yield a polyfunctional carbamic ester monomer according to the present invention.

The third group of the present novel polyfunctional monomers comprises a difunctional monomer represented by the general formula (VI):



wherein R_{10} represents hydrogen or a methyl group.

Specific and non-limiting examples thereof include N-(3-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone, N-(4-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone, N-(3-isopropenyl- α,α -dimethylbenzyl)-5-methacryloyloxymethylene-2-oxazolidone, and N-(4-isopropenyl- α,α -dimethylbenzyl)-5-methacryloyloxymethylene-2-oxazolidone.

These compounds are produced by adding from about 0.8 to about 1.20 mol, preferably from about 0.95 to 1.05 mol of glycidyl acrylate or glycidyl methacrylate dropwise to 1 mol of 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate in a solvent that will not react with the reagents such as benzene, toluene or xylene. The reaction is carried out in the presence of an oxazolidone-producing reaction catalyst such as tributylphosphine oxide-lithium bromide, in an amount of from about 1.0 to about 10 mol %, preferably from about 1.5 to about 5.0 mol %, relative to the 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate. The temperature of the reaction medium is kept at from about 70 to about 150 °C, preferably from about 90 to about 120 °C, so as to allow the reaction to proceed. After the reaction is complete, the reaction medium is purified by chromatography to yield a difunctional monomer having the general formula (V).

Since the present novel polyfunctional monomer has both a functional group whose polymerization speed is high and an isopropenyl group whose polymerization speed is low, where functional group and isopropenyl group will be homopolymerized or copolymerized with a monomer having an acryl group, a methacryl group, a vinylphenyl group, or the like, the control of polymerization is quite easy and a resin can be obtained that is highly transparent and at the same time has excellent surface hardness, heat resistance, and workability as regards severing and cutting thereof, in comparison to polymethyl methacrylate,

polystyrene, polycarbonate, and polydiethylene glycol bisallyl carbonate. Selection of the polymerization conditions of the present monomer is easy. The present polyfunctional monomers are useful as starting materials for producing resins that are suitable for use as glazing materials, for example, for parts pertaining to vehicle's components such as car windows, and for optical elements such as optical disk substrates and lenses of spectacles and cameras.

EXAMPLES

The present invention will now be described more particularly with reference to the following Examples. In the Examples, the parts quoted are parts by weight.

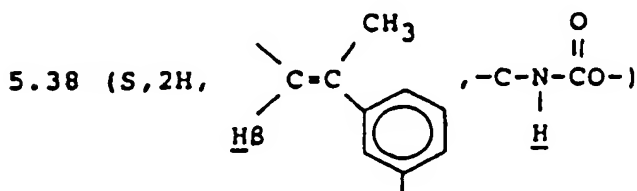
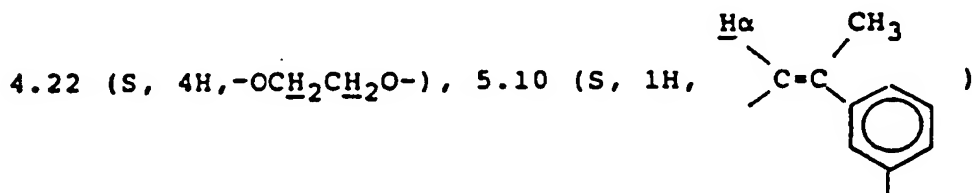
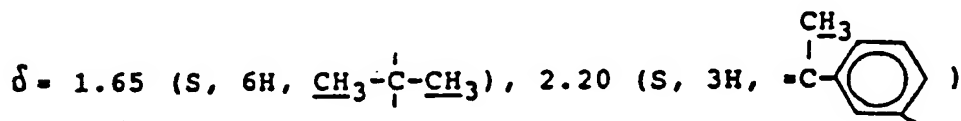
Example 1

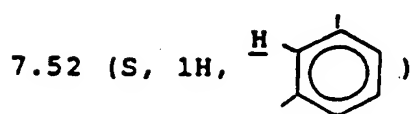
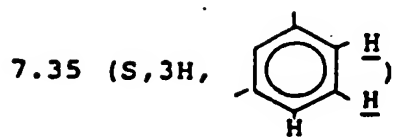
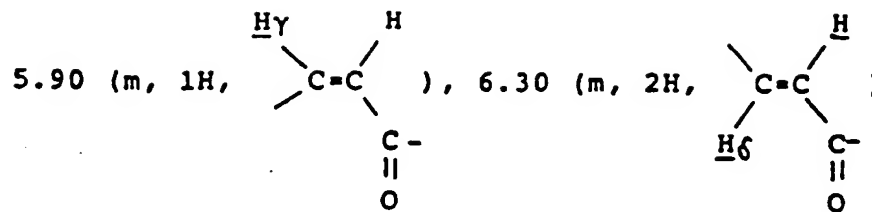
8.3 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, 10.0 parts of toluene, and 4.8 parts of 2-hydroxyethyl acrylate were mixed, and the resulting reaction was carried out for 5 hours with stirring while the temperature of the reaction medium was kept at 100 °C. After the reaction was complete, the reaction medium was condensed. The condensed medium was purified by chromatography to yield 2.9 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2-acryloyloxyethyl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{18}H_{23}NO_4$):

	C	H	N
Found (%)	67.62	7.29	4.39
Calculated (%)	68.12	7.31	4.42

NMR (δ $CDCl_3$)



Example 2

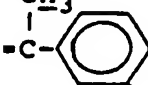
10.0 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, 6.5 parts of 2-hydroxyethyl methacrylate, and 0.1 part of dibutyl tin dilaurate (used as a urethanization reaction-promoting catalyst) were mixed, and the resulting reaction was carried out for 1 hour with stirring while the temperature of the reaction medium was kept at 65 °C. After the reaction was complete, the reaction medium was purified by chromatography to yield 14.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate that was colorless and syrupy.

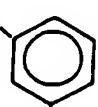
Elemental analysis figures (calculated for $C_{19}H_{25}NO_4$):

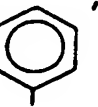
	C	H	N
Found (%)	68.77	7.32	4.28
Calculated (%)	68.86	7.61	4.23

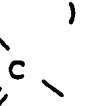
NMR (δ CDCl₃)

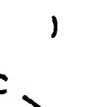
5 $\delta = 1.65$ (s, 6H, $\text{CH}_3\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-CH}_3$), 1.92 (s, 3H, $\text{CH}_2\text{=}\overset{\text{CH}_3}{\underset{\text{O}}{\underset{||}{\text{C}}}}\text{-}$)

10 2.12 (s, 3H, $\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$ ) , 4.20 (s, 4H, $\text{-OCH}_2\text{CH}_2\text{O-}$)

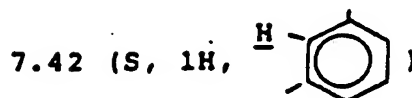
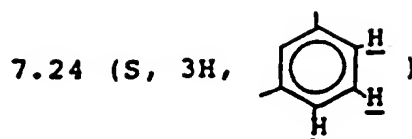
15 5.02 (s, 1H, $\overset{\text{H}\alpha}{\text{C}}\text{=}\overset{\text{CH}_3}{\text{C}}$ )

25 5.30 (s, 2H, $\overset{\text{CH}_3}{\text{C}}\text{=}\overset{\text{H}\beta}{\text{C}}$ ) , $\text{-}\overset{\text{O}}{\underset{||}{\text{C}}}\text{-N-}\overset{\text{H}}{\underset{|}{\text{C}}}\text{-CO-}$)

35 5.50 (s, 1H, $\overset{\text{H}\gamma}{\text{C}}\text{=}\overset{\text{CH}_3}{\text{C}}$ )

45 6.04 (s, 1H, $\overset{\text{H}\delta}{\text{C}}\text{=}\overset{\text{CH}_3}{\text{C}}$ )

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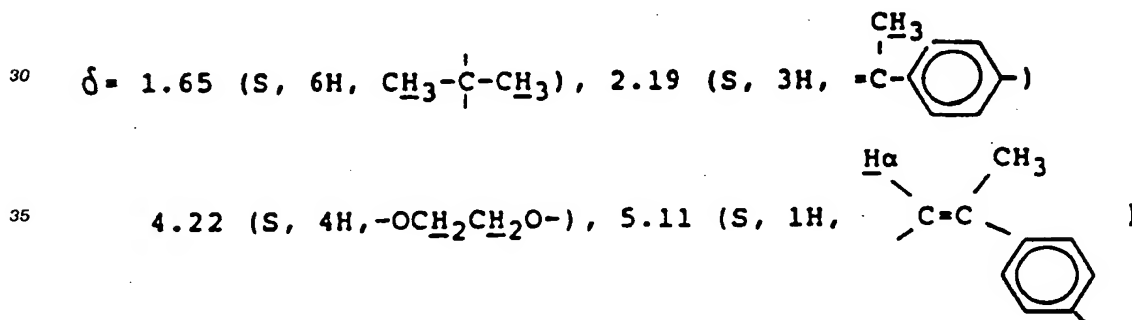
Example 3

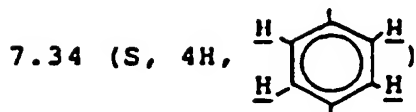
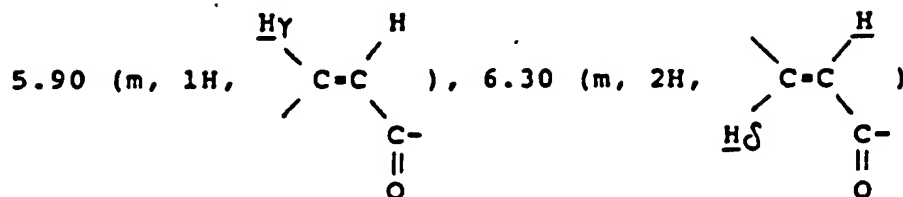
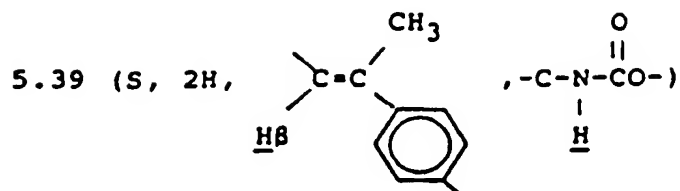
The procedure of Example 1 was repeated, except that 8.3 parts of 4-isopropenyl- α,α -dimethylbenzyl isocyanate were used instead of 8.3 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, thereby producing 3.2 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-2-acryloyloxyethyl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{18}H_{23}NO_4$):

	C	H	N
Found (%)	67.90	7.27	4.37
Calculated (%)	68.12	7.31	4.42

NMR (δ $CDCl_3$)





Example 4

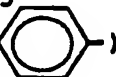
The procedure of Example 2 was repeated, except that 10.0 parts of 4-isopropenyl- α,α -dimethylbenzyl isocyanate were used instead of 10.0 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, thereby producing 14.2 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{19}H_{25}NO_4$):


	C	H	N
Found (%)	68.53	7.40	4.19
Calculated (%)	68.86	7.61	4.23



NMR (δ $CDCl_3$)


$\delta = 1.64$ (s, 6H, $\text{CH}_3\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-CH}_3$), 1.90 (s, 3H, $\text{CH}_2\text{-}\overset{\text{CH}_3}{\underset{\text{||}}{\text{C}}}\text{-}$)


2.10 (s, 3H, $\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$ )

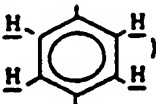
4.20 (s, 4H, $\text{-OCH}_2\text{CH}_2\text{O-}$)

5.03 (s, 1H, $\overset{\text{H}\alpha}{\text{C}}=\overset{\text{CH}_3}{\text{C}}$ )

5.30 (s, 2H, $\overset{\text{H}\beta}{\text{C}}=\overset{\text{CH}_3}{\text{C}}$ , $\text{C}-\overset{\text{O}}{\underset{\text{||}}{\text{N}}}-\text{CO-}$ )

5.52 (s, 1H, $\overset{\text{H}\gamma}{\text{C}}=\overset{\text{CH}_3}{\text{C}}$ )

6.06 (s, 1H, $\overset{\text{H}\delta}{\text{C}}=\overset{\text{CH}_3}{\text{C}}$ )

7.34 (s, 4H, )

Example 5

The procedure of Example 2 was repeated, except that 6.5 parts of 2-hydroxypropyl acrylate were used instead of 6.5 parts of 2-hydroxyethyl methacrylate, and the temperature of the reaction medium

was maintained at 80 °C instead of 65 °C, thereby producing 13.8 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1-acryloyloxypropan-2-yl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{19}H_{25}NO_4$):

	C	H	N
Found (%)	68.66	7.53	4.29
Calculated (%)	68.86	7.61	4.23

NMR (δ $CDCl_3$)

δ = 1.26 (m, 3H, $-\overset{\text{O}}{\underset{\text{||}}{\text{C}}}\overset{\text{CH}_3}{\underset{|}{\text{CH}}}\text{CH}_2-$), 1.68 (s, 6H, $\text{CH}_3-\overset{|}{\underset{|}{\text{C}}}-\text{CH}_3$)

2.18 (s, 3H, $-\overset{\text{CH}_3}{\underset{|}{\text{C}}}-\text{C}_6\text{H}_5$), 4.10 (m, 2H, $-\overset{\text{O}}{\underset{\text{||}}{\text{C}}}\overset{\text{CH}_3}{\underset{|}{\text{CH}}}\text{CH}_2-$)

5.12 (m, 2H, H_α $\text{C}=\text{C}$ C_6H_5 , $-\overset{\text{O}}{\underset{\text{||}}{\text{C}}}\overset{\text{CH}_3}{\underset{|}{\text{CH}}}\text{CH}_2-$)

5.41 (m, 2H, H_β $\text{C}=\text{C}$ C_6H_5 , $-\text{C}-\overset{\text{O}}{\underset{\text{||}}{\text{N}}}-\text{CO}-$)

5.82 (m, 1H, H_γ $\text{C}=\text{C}$ C_6H_5), 6.35 (m, 2H, H_δ $\text{C}=\text{C}$ C_6H_5)

7.36 (s, 3H, C_6H_5)

7.55 (s, 1H, C_6H_5)

Example 6

The procedure of Example 2 was repeated, except that 7.5 parts of 2-hydroxypropyl methacrylate were used instead of 6.5 parts of 2-hydroxyethyl methacrylate, the temperature of the reaction medium was maintained at 80 °C instead of 65 °C, and the amount of the dibutyl tin laurate used was 0.2 part instead of 0.1 part, thereby producing 15.1 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1-methacryloyloxypropan-2-yl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{20}H_{27}NO_4$):

	C	H	N
Found (%)	69.45	7.71	4.01
Calculated (%)	69.54	7.87	4.05

NMR (δ $CDCl_3$)

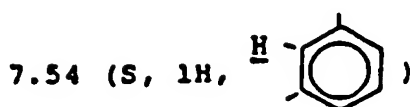
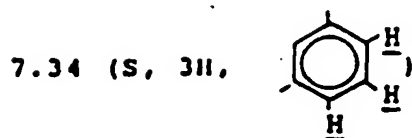
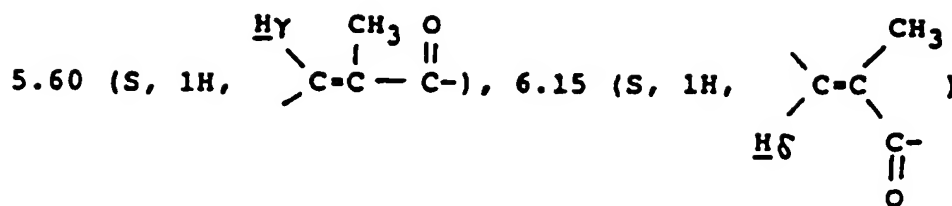
$\delta = 1.24$ (m, 3H, $-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2-$), 1.66 (s, 6H, $\text{CH}_3-\overset{|}{\underset{|}{\text{C}}}-\text{CH}_3$)

1.96 (s, 3H, $\text{CH}_2=\overset{\text{CH}_3}{\underset{|}{\text{C}}}-\overset{\text{O}}{\parallel}\text{C}-$)

2.17 (s, 3H, $-\overset{\text{CH}_3}{\underset{|}{\text{C}}}-\text{C}_6\text{H}_5$), 4.08 (d, 2H, $-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2-$)

5.10 (m, 2H, $\overset{\text{H}_\alpha}{\text{C}}=\overset{\text{CH}_3}{\text{C}}-\text{C}_6\text{H}_5$, $-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2-$)

5.40 (s, 2H, $\overset{\text{H}_\beta}{\text{C}}=\overset{\text{CH}_3}{\text{C}}-\text{C}_6\text{H}_5$, $-\text{C}-\overset{\text{O}}{\parallel}\text{N}-\text{CO}-$)



Example 7

10.0 parts of 4-isopropenyl- α,α -dimethylbenzyl isocyanate, 6.7 parts of 2-hydroxypropyl acrylate, 10.0 parts of benzene, and 0.5 part of dibutyl tin dilaurate (used as a reaction-promoting catalyst) were mixed, and the resulting reaction was carried out for 5 hours with stirring while the temperature of the reaction medium was kept at 60 °C. After the reaction was complete, the reaction medium was purified by chromatography to yield 12.8 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-1-acryloyloxypropan-2-yl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{19}H_{25}NO_4$):

	C	H	N
Found (%)	68.45	7.44	4.07
Calculated (%)	68.86	7.61	4.23

NMR (δ $CDCl_3$)

$\delta = 1.25$ (d, 3H, $\begin{array}{c} \text{O} \quad \text{CH}_3 \\ || \quad | \\ -\text{COCHCH}_2- \end{array}$), 1.66 (s, 6H, $\text{CH}_3-\text{C}(\text{CH}_3)_2-$)

2.18 (s, 3H, $-\text{C}(\text{CH}_3)_2-$), 4.12 (m, 2H, $\begin{array}{c} \text{O} \quad \text{CH}_3 \\ || \quad | \\ -\text{COCHCH}_2- \end{array}$)

5.12 (m, 2H, $\begin{array}{c} \text{H}_\alpha \quad \text{CH}_3 \\ \diagdown \quad / \\ \text{C}=\text{C} \\ | \\ \text{C}_6\text{H}_5 \end{array}$, $\begin{array}{c} \text{O} \quad \text{CH}_3 \\ || \quad | \\ -\text{COCHCH}_2- \end{array}$)

5.40 (m, 2H, $\begin{array}{c} \text{CH}_3 \\ | \\ \text{C}=\text{C}-\text{C}_6\text{H}_4- \\ | \\ \text{H}_\beta \end{array}$, $\begin{array}{c} \text{O} \\ || \\ \text{C}-\text{N}-\text{CO}- \\ | \\ \text{H} \end{array}$)

5.81 (m, 1H, $\begin{array}{c} \text{H}_\alpha \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ | \\ \text{C}=\text{O} \end{array}$), 6.34 (m, 2H, $\begin{array}{c} \text{H} \\ | \\ \text{C}=\text{C} \\ | \\ \text{H}_\delta \quad \text{C}=\text{O} \end{array}$)

7.24 (s, 4H, C_6H_4)

Example 8

12.0 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, 10.0 parts of toluene, and 11.9 parts of glycerol-1,3-diacrylate were mixed, and the resulting reaction was carried out for 3 hours with stirring while the temperature of the reaction medium was kept at 90 °C. After the reaction was complete, the reaction medium was condensed. The condensed medium was purified by chromatography to yield 2.4 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1,3-diacryloyloxypropan-2-yl carbamate that was colorless and syrupy.


Elemental analysis figures (calculated for $\text{C}_{22}\text{H}_{27}\text{NO}_6$):

	C	H	N
Found (%)	65.54	6.57	3.33
Calculated (%)	65.82	6.78	3.49

NMR (δ CDCl_3)


$\delta = 1.66$. (s, 6H, $\text{CH}_3\text{-}\overset{\text{I}}{\underset{\text{I}}{\text{C}}}\text{-CH}_3$)

2.14 (s, 3H, $\text{=C}\overset{\text{CH}_3}{\text{---}}$)

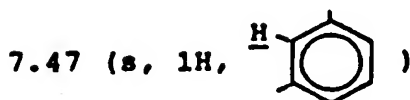
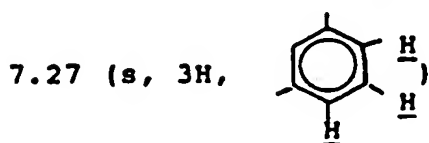
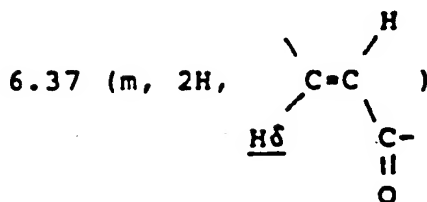
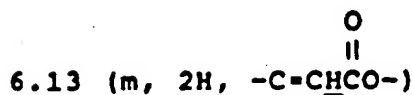
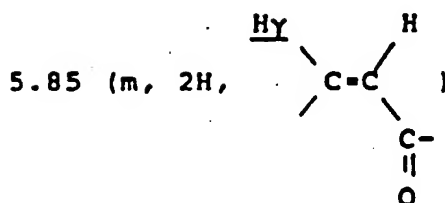
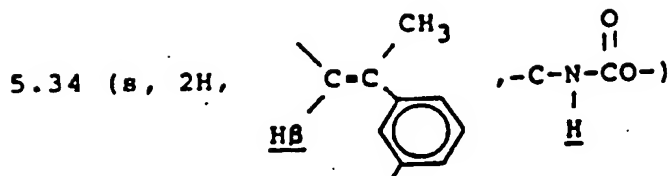


4.36 (s, 4H, $\text{-CH}_2\overset{\text{O}}{\parallel}\text{OC-}$)

5.06 (s, 1H, $\overset{\text{Ha}}{\text{---}}\text{C}=\text{C}\overset{\text{CH}_3}{\text{---}}$)



5.15 (s, 1H, $\text{-COCH}\overset{\text{O}}{\parallel}\text{---}$)



Example 9

48.0 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, 54.4 parts of glycerol-1,3-dimethacrylate, and 0.5 part of dibutyl tin dilaurate (used as a reaction-promoting catalyst) were mixed, and the resulting reaction was carried out for 1 hour with stirring while the temperature of the reaction medium was kept at 60 °C. After the reaction was complete, the reaction medium was purified by chromatography to yield 63.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl-1,3-dimethacryloyloxypropan-2-yl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{24}H_{31}NO_6$) :

	C	H	N
Found (%)	66.90	7.13	3.09
Calculated (%)	67.11	7.27	3.26

NMR (δ $CDCl_3$)

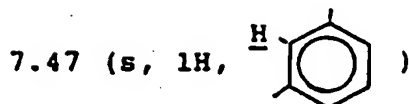
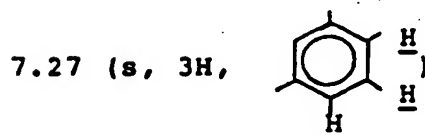
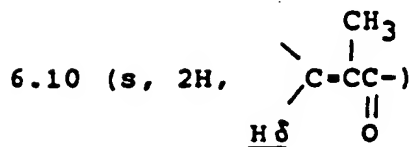
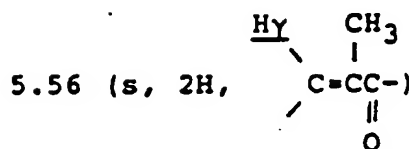
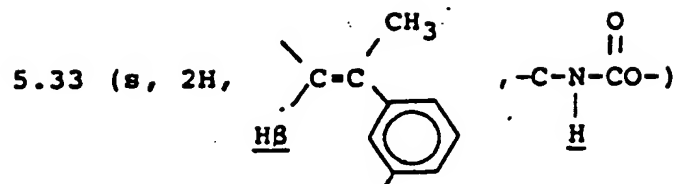
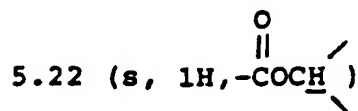
$\delta = 1.66$ (s, 6H, $\text{CH}_3-\overset{\text{I}}{\underset{\text{I}}{\text{C}}}-\text{CH}_3$)

1.92 (s, 6H, $\text{-C}(\overset{\text{CH}_3}{\text{CH}_3})\text{-CO-}$)

2.13 (s, 3H, $\text{-C}(\text{CH}_3)\text{-}$)

4.25 (m, 4H, $\text{-CH}_2\text{OC-}$)

5.06 (s, 1H, H_α)



Example 10

The procedure of Example 9 was repeated, except that 51.5 parts of glycerol-1-acrylate-3-methacrylate were used instead of 54.4 parts of glycerol-1,3-dimethacrylate, thereby producing 71.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1-acryloyloxy-3-methacryloyloxypropan-2-yl carbamate that was colorless and syrupy.

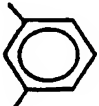
Elemental analysis figures (calculated for $\text{C}_{23}\text{H}_{29}\text{NO}_6$):

	C	H	N
Found (%)	66.11	6.99	3.23
Calculated (%)	66.49	7.04	3.37

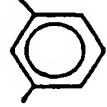
NMR (δ CDCl_3)

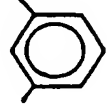
$\delta = 1.67$ (s, 6H, $\text{CH}_3-\overset{\text{CH}_3}{\underset{|}{\text{C}}}-\text{CH}_3$)

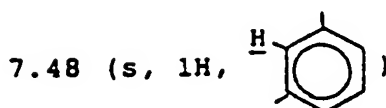
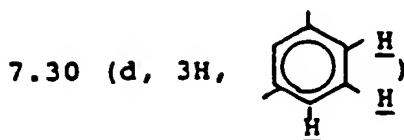
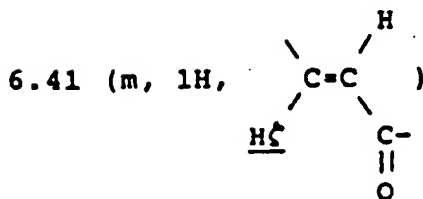
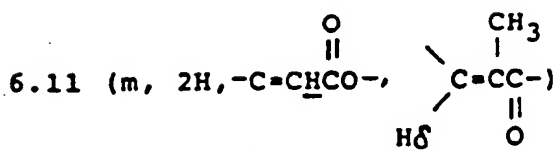
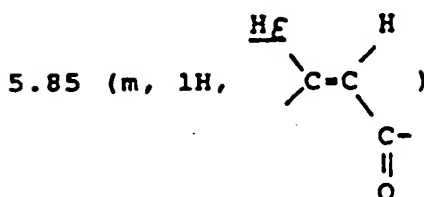
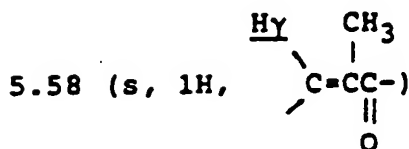
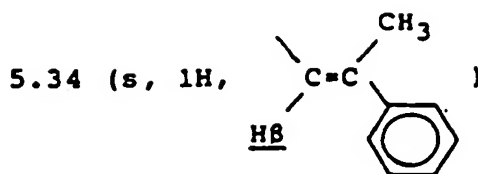
1.93 (s, 3H, $\text{CH}_3-\overset{\text{CH}_3}{\underset{\text{O}}{\underset{||}{\text{C}}}}-\text{CO}-$)

2.14 (s, 3H, $\text{CH}_3-\overset{\text{CH}_3}{\underset{|}{\text{C}}}-$)


4.26 (m, 4H, $-\text{CH}_2-\overset{\text{O}}{\underset{||}{\text{C}}}-$)

5.07 (s, 1H, $\text{H}_\alpha-\overset{\text{CH}_3}{\underset{|}{\text{C}}}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}-$)


5.24 (s, 2H, $-\overset{\text{O}}{\underset{||}{\text{C}}}-\text{CH}_2-\text{C}-\overset{\text{O}}{\underset{||}{\text{N}}}-\text{CO}-$)




Example 11

The procedure of Example 9 was repeated, except that 48.0 of parts of 4-isopropenyl- α,α -dimethylbenzyl isocyanate, and 47.8 parts of glycerol-1,3-diacrylate were used instead of 48.0 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, and 54.4 parts of glycerol-1,3-dimethacrylate, respectively, thereby producing 62.1 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-1,3-diacryloyloxypropyl-2-yl carbamate that was colorless and syrupy.

Elemental analysis figures (calculated for $C_{22}H_{27}NO_6$):

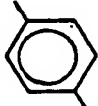
EP 0 351 534 B1

	C	H	N
Found (%)	65.31	6.49	3.40
Calculated (%)	65.82	6.78	3.49

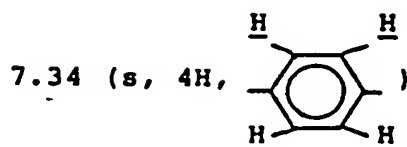
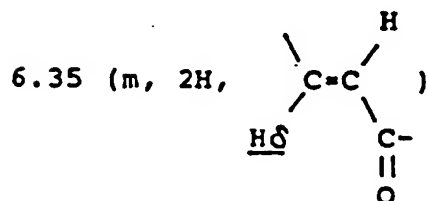
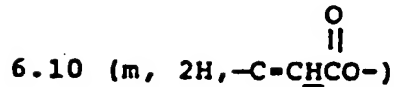
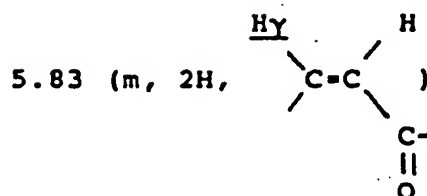
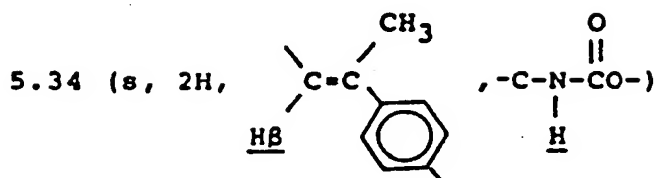
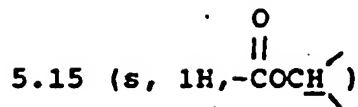
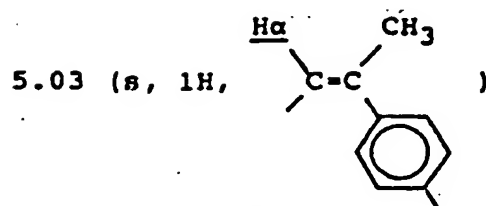
NMR (δ CDCl_3)

$\delta = 1.66$ (s, 6H, $\text{CH}_3-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\text{CH}_3$)

2.14 (s, 3H, CH_3)



4.35 (s, 4H, $-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-$)



Example 12

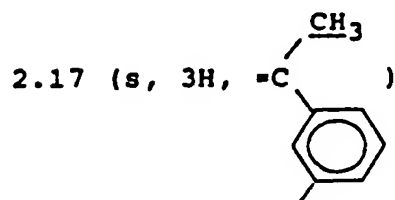
The procedure of Example 8 was repeated, except that 11.9 parts of glycerol-2,3-diacrylate were used instead of 11.9 parts of glycerol-1,3-diacrylate, thereby producing 2.8 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2,3-diacryloyloxypropan-1-yl carbamate that was colorless syrupy.

Elemental analysis figures (calculated for $\text{C}_{22}\text{H}_{27}\text{NO}_6$) :

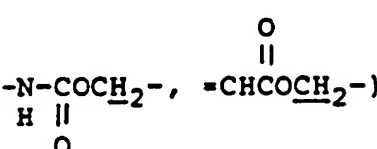
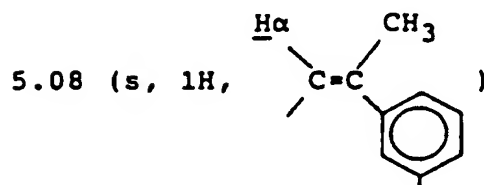
	C	H	N
Found (%)	65.69	6.46	3.31
Calculated (%)	65.82	6.78	3.49

NMR (δ CDCl_3)

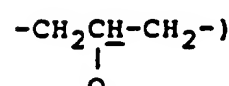
$\delta = 1.68$ (s, 6H, $\text{CH}_3-\text{C}(\text{CH}_3)_2$)

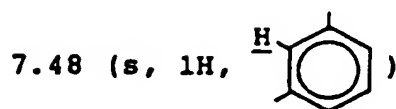
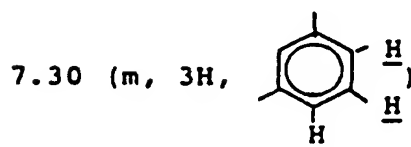
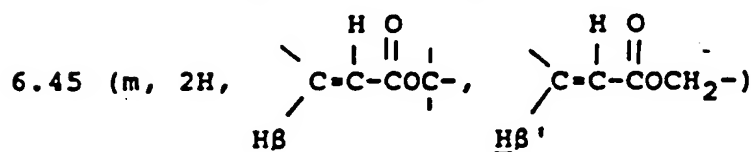
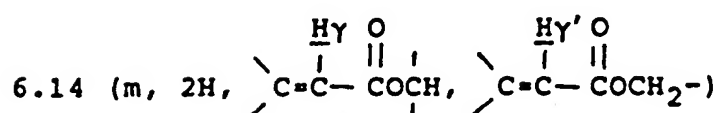
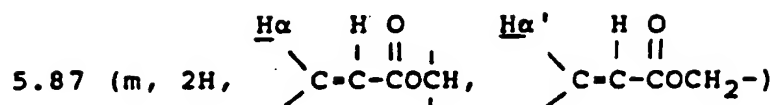
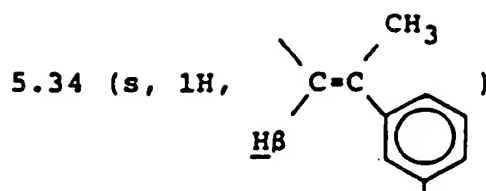


4.32 (m, 4H, $-\text{N}-\text{COCH}_2-$, $-\text{CHCOCH}_2-$)

5.21 (m, 1H, $-\text{CH}_2\text{CH}-\text{CH}_2-$)





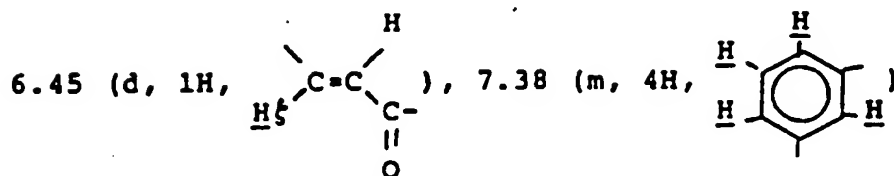
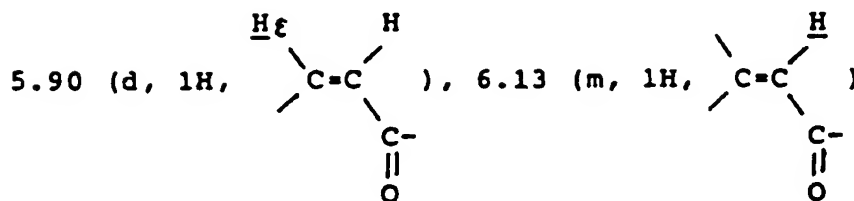
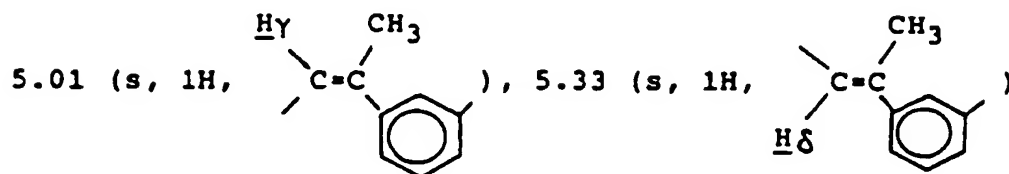
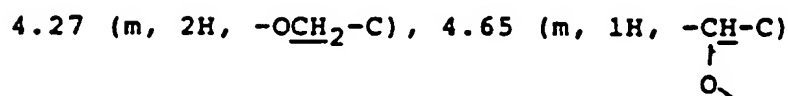
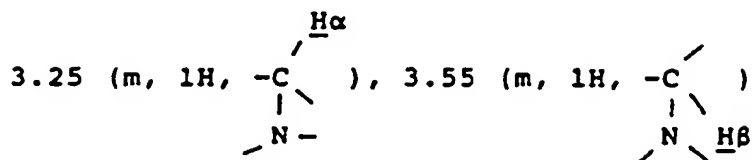
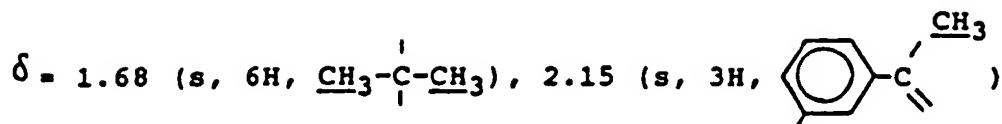
Example 13

20.0 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, 50.0 parts of toluene, 0.8 part of tributylphosphine oxide, and 0.2 part of lithium bromide were refluxed with stirring, and 12.9 parts of glycidyl acrylate were added dropwise thereto under reflux and the resulting reaction was allowed to proceed for 1 hour. After the reaction was complete, the reaction medium was condensed and purified by chromatography, thereby yielding 24.2 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone that was colorless and watery.

Elemental analysis figures (calculated for $C_{19}H_{23}NO_4$):

	C	H	N
Found (%)	68.92	6.91	4.37
Calculated (%)	69.28	7.04	4.25

NMR (δ / $CDCl_3$)



Example 14

The procedure of Example 13 was repeated, except that 20.2 parts of 4-isopropenyl- α,α -dimethylbenzyl isocyanate were used instead of 20.2 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, thereby producing 25.5 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone that was colorless and watery.

Elemental analysis figures (calculated for $\text{C}_{19}\text{H}_{23}\text{NO}_4$):

	C	H	N
Found (%)	69.56	7.18	4.21
Calculated (%)	69.28	7.04	4.25

NMR (δ /CDCl₃)

$\delta = 1.68$ (s, 6H, $\text{CH}_3\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-CH}_3$), 2.17 (s, 3H, $\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{=}$)

3.25 (m, 1H, $\text{-}\overset{\text{H}\alpha}{\underset{|}{\text{C}}}\text{-}$), 3.55 (m, 1H, $\text{-}\overset{\text{H}\beta}{\underset{|}{\text{N}}}\text{-}$)

4.27 (m, 2H, $\text{-OCH}_2\text{-C}$), 4.65 (m, 1H, $\text{-}\overset{\text{O-}}{\underset{|}{\text{CH}}}\text{-C}$)

4.98 (s, 1H, $\text{-}\overset{\text{H}\gamma}{\underset{|}{\text{C}}}\text{=}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$), 5.30 (s, 1H, $\text{-}\overset{\text{H}\delta}{\underset{|}{\text{C}}}\text{=}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$)

5.90 (d, 1H, $\text{-}\overset{\text{H}\epsilon}{\underset{|}{\text{C}}}\text{=}\overset{\text{H}}{\underset{|}{\text{C}}}\text{-}$), 6.13 (m, 1H, $\text{-}\overset{\text{H}}{\underset{|}{\text{C}}}\text{=}\overset{\text{H}}{\underset{|}{\text{C}}}\text{-}$)

6.45 (d, 1H, $\text{-}\overset{\text{H}\zeta}{\underset{|}{\text{C}}}\text{=}\overset{\text{H}}{\underset{|}{\text{C}}}\text{-}$), 7.40 (m, 4H, $\text{-}\overset{\text{H}}{\underset{|}{\text{C}}}\text{=}\overset{\text{H}}{\underset{|}{\text{C}}}\text{-}$)

Example 15

20.7 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, 50.0 parts of toluene, 0.8 parts of tributylphosphine oxide, and 0.2 part of lithium bromide were stirred under reflux, 14.2 parts of glycidyl

methacrylate were added thereto dropwise, and the resulting reaction was allowed to proceed under reflux for 1 hour. After the reaction was complete, the reaction medium was condensed, and then was purified by chromatography to yield 30.6 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-5-methacryloyloxymethylene-2-oxazolidone that was colorless and watery.

Elemental analysis figures (calculated for $C_{20}H_{25}NO_4$):

	C	H	N
Found (%)	70.16	7.05	4.23
Calculated (%)	69.95	7.34	4.08

NMR (δ / $CDCl_3$)

$\delta = 1.83$ (s, 6H, $\text{CH}_3-\text{C}-\text{CH}_3$), 1.98 (s, 3H, $\text{CH}_2=\text{C}-\text{C}-$)

2.18 (s, 3H, $\text{C}(\text{CH}_3)=$), 3.30 (m, 1H, $-\text{C}-\text{H}_\alpha$)

3.58 (m, 1H, $-\text{C}-\text{H}_\beta$), 4.30 (m, 2H, $-\text{OCH}_2-\text{C}-$)

4.66 (m, 1H, $-\text{CH}-\text{C}-$), 5.12 (s, 1H, $\text{C}=\text{C}-\text{H}_\gamma$)

5.38 (s, 1H, $\text{C}=\text{C}-\text{H}_\delta$), 5.65 (s, 1H, $\text{C}=\text{C}-\text{H}_\epsilon$)

6.17 (s, 1H, $\text{C}=\text{C}-\text{H}_\zeta$), 7.36 (m, 4H, C_6H_4)

Example 16

The procedure of Example 15 was repeated, except that 20.2 parts of 4-isopropenyl- α,α -dimethylbenzyl isocyanate were used instead of 20.02 parts of 3-isopropenyl- α,α -dimethylbenzyl isocyanate, thereby producing 28.6 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-5-methacryloyloxy methylene-2-oxazolidone that was colorless and watery.

Elemental analysis figures (calculated for $C_{20}H_{25}NO_4$):

	C	H	N
Found (%)	69.71	7.16	4.17
Calculated (%)	69.95	7.34	4.08

NMR (δ /CDCl₃)

$\delta = 1.83$ (s, 6H, $\text{CH}_3\text{-}\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-CH}_3$), 1.98 (s, 3H, $\text{CH}_2\text{-}\overset{\text{CH}_3}{\underset{\text{O}}{\underset{||}{\text{C}}}}\text{-C-}$)

2.18 (s, 3H, $\text{-}\overset{\text{CH}_3}{\underset{||}{\text{C}}}\text{-}$), 3.30 (m, 1H, $\text{-}\overset{\text{H}\alpha}{\underset{\text{N}}{\text{C}}}\text{-}$)

3.57 (m, 1H, $\text{-}\overset{\text{H}\beta}{\underset{\text{N}}{\text{C}}}\text{-}$), 4.29 (m, 2H, $\text{-OCH}_2\text{-C-}$)

4.66 (m, 1H, $\text{-}\overset{\text{O-}}{\underset{|}{\text{CH}}}\text{-C-}$), 5.09 (s, 1H, $\text{-}\overset{\text{H}\gamma}{\underset{|}{\text{C}}}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$)

5.35 (s, 1H, $\text{-}\overset{\text{H}\delta}{\underset{|}{\text{C}}}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$), 5.38 (s, 1H, $\text{-}\overset{\text{H}\epsilon}{\underset{|}{\text{C}}}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$)

5.65 (s, 1H, $\text{-}\overset{\text{H}\zeta}{\underset{|}{\text{C}}}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}\text{-}$), 7.38 (m, 4H, $\text{H-}\overset{\text{H}}{\underset{\text{H}}{\text{C}}}\text{-}$)

APPLICATION EXAMPLES

Various applications of the present invention will now be described with reference to Application Examples, wherein the parts quoted represent parts by weight and the percentages quoted represent percent by weight.

Application Example 1

30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate, 0.1 part of bis(4-t-butylcyclohexyl) peroxydicarbonate, and 0.1 part of t-butyl peroxyisopropyl carbonate were mixed to form a uniform mixture, and the mixture was deaerated under reduced pressure and cast in a mold composed of a 150 mm x 150 mm glass sheet, and a vinyl chloride gasket. The cast mixture was then polymerized for 1 hour at 60 °C, and further for 1 hour at 120 °C, whereafter the platelike polymerized item was removed from the mold. The hardness of the plate, as measured by the pencil hardness method (JIS-K-5401), was found to be 5H, the chemical resistance thereof was good, severing of the plate with a metal severing saw was possible, and grinding of the plate with a lens polisher for machining lenses of spectacles was also possible. The results of these tests, together with the results obtained in Application Examples 2 to 6, are given in Table 1.

The physical properties were measured by the following methods:

- (1) Appearance: the platelike polymerized item was visually observed, without magnification.
- (2) Light transmittance: was measured in accordance with ASTM D1003.
- (3) Surface hardness: a pencil hardness test for paints according to JIS K-5401 was used.
- (4) Heat resistance: after the polymerized item was allowed to stand in a hot-air drying chamber at 120 °C for 1 hour, it was visually observed, without magnification. When it was not colored and was free from surface imperfections, it was judged to be O and when it was colored and had surface imperfections, it was judged to be X.
- (5) Workability: when the polymerized item could be ground by a machine for working lenses of spectacles, it was judged to be O, and when it could not be cut, it was judged to be X.
- (6) Chemical resistance: the polymerized item was immersed in isopropanol and toluene at room temperature for 24 hours. When it was not marked by an HB pencil, it was judged as O, whereas when it was marked by an HB pencil, it was judged as X.

Application Example 2

The procedure of Application Example 1 was repeated, except that 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1-acryloyloxypropan-2-yl carbamate were used instead of 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate, thereby producing a platelike polymerized item.

The pencil hardness of the plate was 5H, the chemical resistance thereof was good, severing of the plate with a metal cutting saw was possible, and grinding of the plate with a lens polisher for working lenses of spectacles was also possible.

Application Example 3

The procedure of Application Example 1 was repeated, except that 30.0 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-2-acryloyl-oxyethyl carbamate were used instead of 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate, thereby producing a platelike polymerized item.

The pencil hardness of the plate was 5H, the chemical resistance thereof was good, severing of the plate with a metal cutting saw was possible, and grinding of the plate with a lens polisher for working lenses of spectacles was also possible.

Application Example 4

The procedure of Application Example 1 was repeated, except that 30.0 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-1-methacryloyloxypropan-2-yl carbamate were used instead of 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-2-methacryloyloxyethyl carbamate, thereby producing a platelike polymerized item.

The pencil hardness of the plate was 5H, the chemical resistance thereof was good, severing of the plate with a metal cutting saw was possible, and grinding of the plate with a lens polisher for working lenses of spectacles was also possible.

5 Application Example 5

30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)acryloyloxyethyl carbamate, 1.5 parts of styrene, 0.1 part of t-butyl peroxyisobutyrate, and 0.1 part of t-butyl peroxyisopropyl carbonate were mixed uniformly, and the resulting mixture was cast in a mold composed of a 150 mm x 150 mm glass sheet, and a vinyl chloride gasket. After polymerization at 70 °C for 1 hour, and further at 120 °C for 1 hour, a platelike polymerized item was removed from the mold.

The pencil hardness of the plate was 5H, the chemical resistance thereof was good, severing of the plate with a metal cutting saw was possible, and grinding of the plate with a lens polisher for working lenses of spectacles was also possible.

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Application Example 6

30.0 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)methacryloyloxypropyl carbamate, 1.5 parts of methyl methacrylate, 0.1 part of bis(4-t-butylcyclohexyl) peroxydicarbonate, and 0.1 part of t-butyl peroxyisopropyl carbonate were mixed uniformly, and the resulting mixture was cast in a mold composed of a 150 mm x 150 mm glass sheet, and a vinyl chloride gasket. After polymerization at 60 °C for 1 hour, and further at 120 °C for 1 hour, a platelike polymerized item was removed from the mold.

The pencil hardness of the plate was 5H, chemical resistance thereof was good, severing of the plate with a metal cutting saw was possible, and grinding of the plate with a lens polisher for working lenses of spectacles was also possible.

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Table 1

	Application Example 1	Application Example 2	Application Example 3	Application Example 4	Application Example 5	Application Example 6
Appearance	colorless, transparent	colorless transparent	colorless transparent	colorless transparent	colorless transparent	colorless transparent
Light transmittance (%)	91	91	91	90	90	91
Surface hardness	5H	5H	5H	5H	5H	5H
Heat resistance	○	○	○	○	○	○
Workability	○	○	○	○	○	○
Chemical resistance	○	○	○	○	○	○

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Application Example 7

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30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1,3-diacryloyloxypropan-2-yl carbamate, 0.03 part of lauroyl peroxide, and 0.15 part of benzoyl peroxide were mixed uniformly, and the resulting mixture was cast in a mold composed of a 150 mm x 150 mm glass sheet, and a vinyl chloride gasket. After polymerization at 55 °C for 1 hour, and further at 130 °C for 1 hour, a platelike polymerized item was removed from the mold. The physical properties thereof are shown in Table 2 together with those of Application Examples 8 to 11.

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Application Example 8

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The procedure of Application Example 7 was repeated, except that 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1,3-dimethacryloyloxypropan-2-yl carbamate were used instead of 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1,3-diacryloyloxypropan-2-yl carbamate, the polymerization was effected for 1 hour at 60 °C instead of 55 °C, and further for 2 hours at 140 °C instead of 130 °C, thereby producing a platelike polymerized item.

Application Example 9

The procedure of Application Example 8 was repeated, except that 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1-acryloyloxy-3-methacryloyloxypropan-2-yl carbamate were used instead of 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1,3-dimethacryloyloxypropan-2-yl carbamate, thereby producing a platelike polymerized item.

Application Example 10

The procedure of Application Example 8 was repeated, except that 30.0 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-1,3-acryloyloxypropan-2-yl carbamate were used instead of 30.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-1,3-dimethacryloyloxypropan-2-yl carbamate, thereby producing a platelike polymerized item.

Table 2

	Application Example 7	Application Example 8	Application Example 9	Application Example 10	Application Example 11
Appearance	colorless, transparent	colorless transparent	colorless transparent	colorless transparent	colorless transparent
Light transmittance (%)	91	91	91	91	91
Surface hardness	9H	5H	6H	9H	9H
Heat resistance	○	○	○	○	○
Workability	○	○	○	○	○
Chemical resistance	○	○	○	○	○

Application Example 12

0.2 part of benzoyl peroxide was added to 20.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone, they were mixed well, and the mixture deaerated to form a uniform liquid. The liquid was then cast in a mold composed of a 150 mm x 150 mm glass sheet, and a vinyl chloride gasket. After polymerization at from 55 °C to 140 °C for 1.5 hours in a hot-air oven for polymerization, a platelike polymerized item was removed from the mold. The physical properties are shown in Table 3 together with those of Application Examples 13 to 15.

Application Example 13

The procedure of Application Example 12 was repeated, except that 20.0 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone were used instead of 20.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone, thereby producing a platelike polymerized item.

Application Example 14

The procedure of Application Example 12 was repeated, except that 20.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-5-methacryloyloxymethylene-2-oxazolidone were used instead of 20.0 parts of N-(3-isopropenyldimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone, thereby producing a platelike polymerized item.

Application Example 15

The procedure of Application Example 12 was repeated, except that 20.0 parts of N-(4-isopropenyl- α,α -dimethylbenzyl)-5-methacryloyloxymethylene-2-oxazolidone were used instead of 20.0 parts of N-(3-isopropenyl- α,α -dimethylbenzyl)-5-acryloyloxymethylene-2-oxazolidone, thereby producing

a platelike polymerized item.

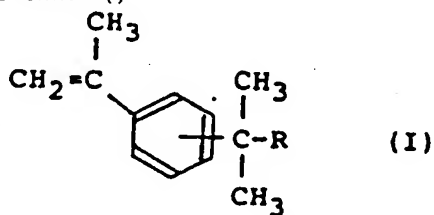
Although the present invention has been described in connection with various preferred embodiments thereof, it is evident that other embodiments thereof will be apparent to those skilled in the art from a reading of the present specification and practice of the invention disclosed herein. Accordingly, it is intended that the true scope and spirit of the invention be indicated by the following claims.

Table 3

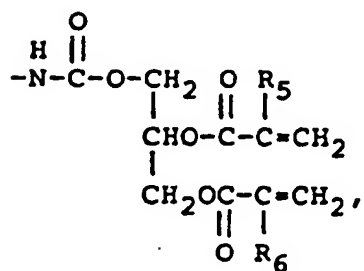
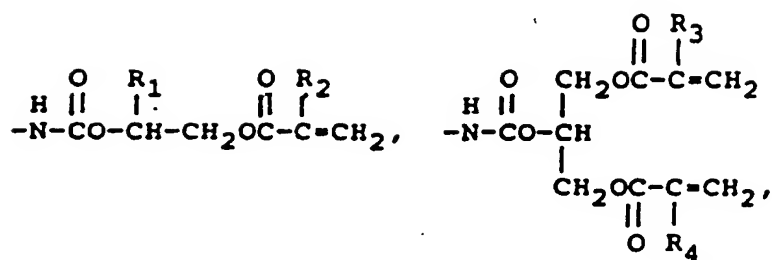
	Application Example 12	Application Example 13	Application Example 14	Application Example 15
Appearance	○	○	○	○
Surface hardness	5H	5H	4H	4H
Heat resistance	○	○	○	○
Chemical resistance	○	○	○	○
Workability	○	○	○	○

Claims

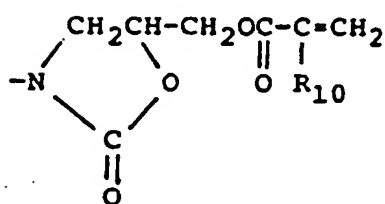
1. A polyfunctional monomer of the formula (I) :



wherein R is selected from the group consisting of

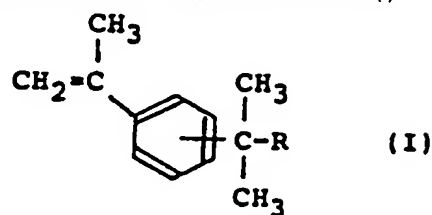


and

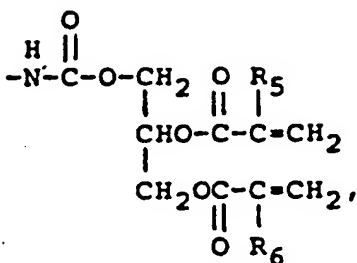
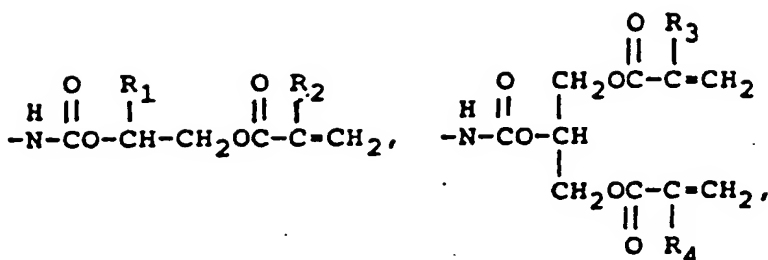


R₁ to R₁₀ are each independently selected from the group consisting of hydrogen and a methyl group.

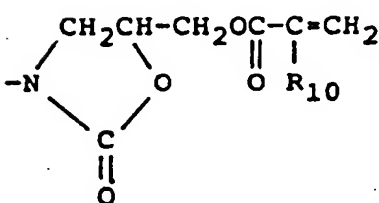
2. A process for producing a polyfunctional monomer of the formula (I) :



wherein R is selected from the group consisting of

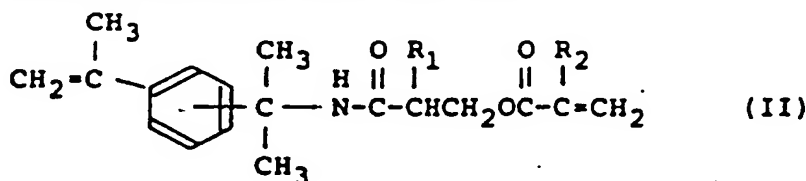


and



R_1 to R_{10} are each independently selected from the group consisting of hydrogen and a methyl group, comprising reacting a compound selected from the group consisting of 3-isopropenyl- α,α -dimethyl benzyl isocyanate and 4-isopropenyl- α,α -dimethyl benzyl isocyanate with a compound selected from the group consisting of 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate, 2-hydroxypropyl methacrylate, glycerol diacrylate, glycerol acrylate methacrylate, glycerol dimethacrylate, glycidyl methacrylate and glycidyl acrylate.

3. A process for producing a difunctional monomer of the formula:



wherein R_1 and R_2 are each independently selected from the group consisting of hydrogen and a methyl group, comprising reacting a compound selected from the group consisting of 3-isopropenyl- α,α -dimethylbenzyl isocyanate and 4-isopropenyl- α,α -dimethylbenzyl isocyanate with a compound selected from the group consisting of 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate and 2-hydroxypropyl methacrylate.

4. The process of claim 3, wherein compound selected from the group consisting of 3-isopropenyl- α,α -dimethylbenzyl isocyanate and 4-isopropenyl- α,α -dimethylbenzyl isocyanate is reacted with said compound selected from the group consisting of 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate and 2-hydroxypropyl methacrylate in a molar ratio of from about 1 : 1 to about 1 : 1.2.

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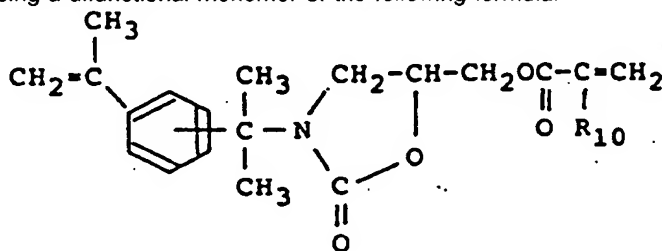


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15. A process for producing a polyfunctional monomer as claimed in claim 13, wherein said reacting step is carried out at a reagent temperature of 25 to 110 °C.
16. A process for producing a polyfunctional monomer as claimed in claim 14, wherein said reacting step is carried out at a reagent temperature of 25 to 110 °C.
17. A process for producing a polyfunctional monomer as claimed in claim 13, wherein said reacting step is carried out in the presence of a urethanization - promoting catalyst.
18. A process for producing a polyfunctional monomer as claimed in claim 17, wherein said urethanization - promoting catalyst is present in an amount of 0.1 to 5 wt. % based on the weight of the isocyanate.
19. A process for producing a polyfunctional monomer as claimed in claim 17, wherein said urethanization - promoting catalyst is dibutyl tin dilaurate.
20. A process for producing a polyfunctional monomer as claimed in claim 13, wherein said reacting step is carried out in the presence of a solvent.
21. A process for producing a polyfunctional monomer as claimed in claim 20, wherein said solvent is selected from the group consisting of hexane, benzene and toluene.
22. A process for producing a polyfunctional monomer as claimed in claim 14, wherein said reacting step is carried out in the presence of a urethanization - promoting catalyst.
23. A process for producing a difunctional monomer of the following formula:



- wherein R_{10} represents hydrogen or a methyl group, comprising reacting 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate and glycidyl methacrylate or glycidyl acrylate in a solvent that is inert with respect to these materials, in the presence of an oxazolidone - producing reaction catalyst.
24. A process for producing a difunctional monomer as claimed in claim 23, wherein the molar ratio of 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate to glycidyl methacrylate or glycidyl acrylate is 1 : 0.80 to 1.20.
25. A process for producing a difunctional monomer as claimed in claim 23, wherein said reacting step is carried out at a reagent temperature of 70 to 150 °C.
26. A process for producing a difunctional monomer as claimed in claim 24, wherein said reaction step is carried out at a reagent temperature of 70 to 150 °C.
27. A process for producing a difunctional monomer as claimed in claim 23, wherein said oxazolidone - producing reaction catalyst is present in an amount of 1.0 to 10 mol % relative to the isocyanate.
28. A process for producing a difunctional monomer as claimed in claim 23, wherein said oxazolidone - producing reaction catalyst is tributylphosphine oxide - lithium bromide.

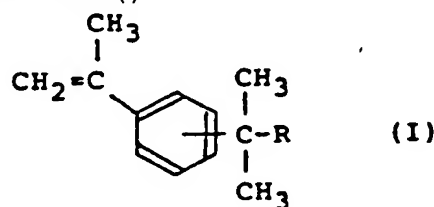
29. A process for producing a difunctional monomer as claimed in claim 23, wherein said inert solvent is selected from the group consisting of benzene, toluene and xylene.

30. A process for producing a difunctional monomer as claimed in claim 23, comprising reacting 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate with glycidyl methacrylate or glycidyl acrylate in the presence of an oxazolidone-producing reaction catalyst in an amount of 1.0 to 10 mol % for 1 mol of the 3-isopropenyl- α,α -dimethylbenzyl isocyanate or 4-isopropenyl- α,α -dimethylbenzyl isocyanate.

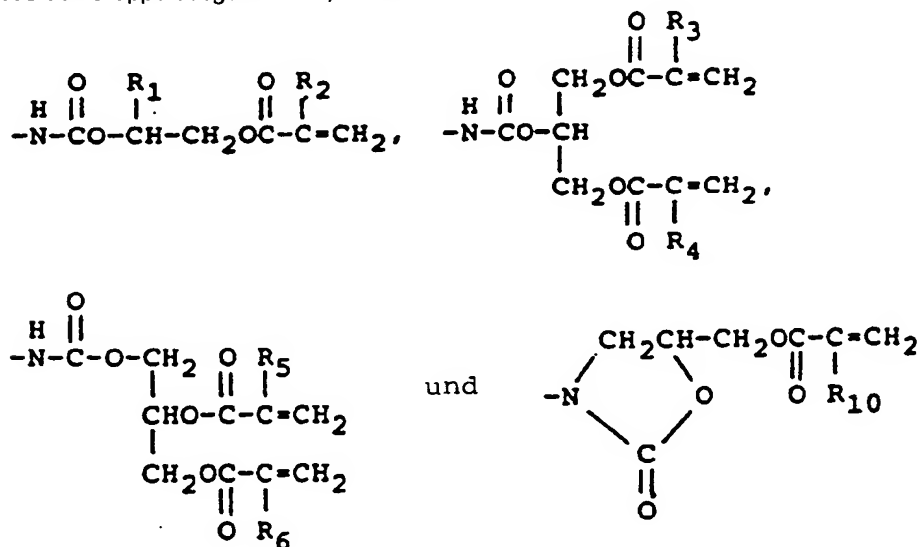
31. A process for producing a difunctional monomer as claimed in claim 30, wherein said oxazolidone-producing reaction catalyst is tributylphosphine oxide-lithium bromide.

Patentansprüche

1. Ein polyfunktionelles Monomer der Formel (I):

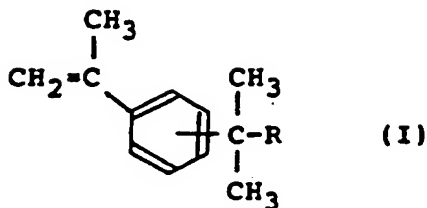


worin R aus der Gruppe ausgewählt ist, die aus

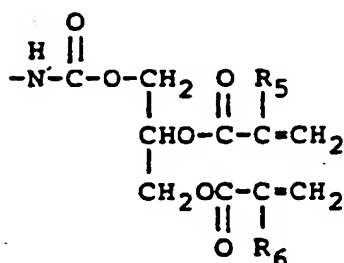
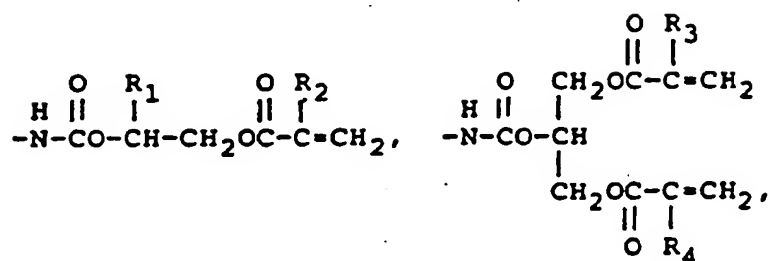


besteht, wobei R_1 bis R_{10} jeweils unabhängig aus der Gruppe ausgewählt sind, die aus Wasserstoff und einer Methylgruppe besteht.

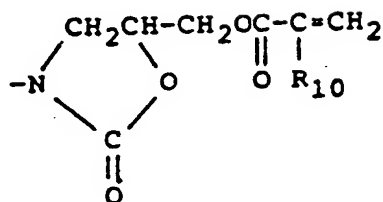
2. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren der Formel (I):



worin R aus der Gruppe ausgewählt ist, die aus



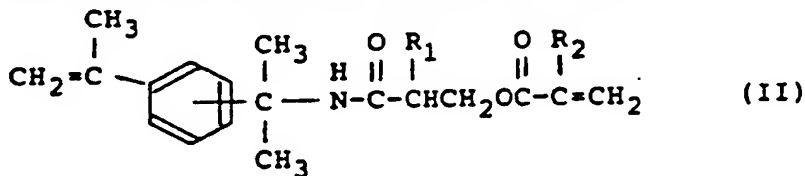
und



besteht, wobei R₁ bis R₁₀ jeweils unabhängig aus der Gruppe ausgewählt sind, die aus Wasserstoff und einer Methylgruppe besteht,

das das Umsetzen einer Verbindung, die aus der Gruppe ausgewählt ist, die aus 3-Isopropenyl- α,α -dimethylbenzylisocyanat und 4-Isopropenyl- α,α -dimethylbenzylisocyanat besteht, mit einer Verbindung, die aus der Gruppe ausgewählt ist, die aus 2-Hydroxyethylacrylat, 2-Hydroxyethylmethacrylat, 2-Hydroxypropylacrylat, 2-Hydroxypropylmethacrylat, Glyceroldiacrylat, Glycerolacrylatmethacrylat, Glyceroldimethacrylat, Glycidylmethacrylat und Glycidylacrylat besteht, umfaßt.

3. Ein Verfahren zum Herstellen eines difunktionellen Monomeren der Formel:

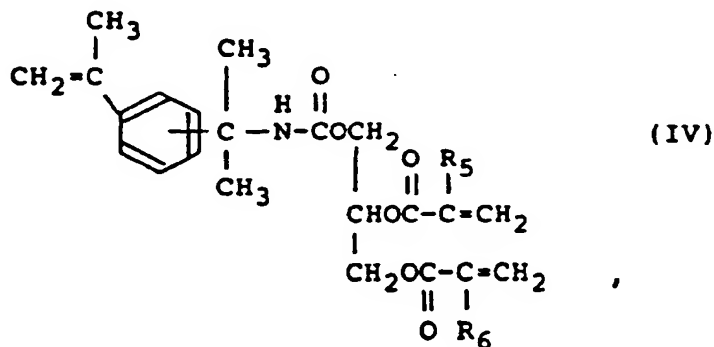
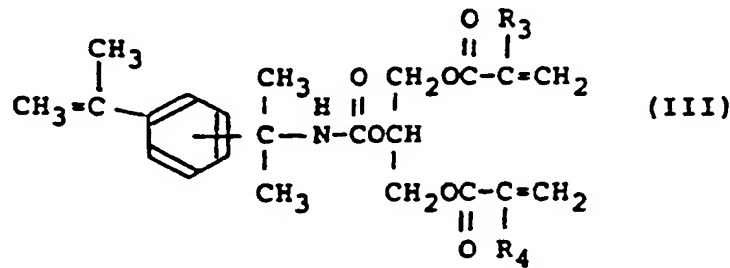


in der R₁ und R₂ jeweils unabhängig aus der Gruppe ausgewählt sind, die aus Wasserstoff und einer Methylgruppe besteht, das das Umsetzen einer Verbindung, die aus der Gruppe ausgewählt ist, die aus 3-Isopropenyl- α,α -dimethylbenzylisocyanat und 4-Isopropenyl- α,α -dimethylbenzylisocyanat besteht, mit einer Verbindung, die aus der Gruppe ausgewählt ist, die aus 2-Hydroxyethylacrylat, 2-Hydroxyethylmethacrylat, 2-Hydroxypropylacrylat und 2-Hydroxypropylmethacrylat besteht, umfaßt.

4. Das Verfahren nach Anspruch 3, bei dem die Verbindung, die aus der Gruppe ausgewählt ist, die aus 3-Isopropenyl- α,α -dimethylbenzylisocyanat und 4-Isopropenyl- α,α -dimethylbenzylisocyanat

besteht, mit der besagten Verbindung, die aus der Gruppe ausgewählt ist, die aus 2-Hydroxyethyl-acrylat, 2-Hydroxyethylmethacrylat, 2-Hydroxypropylacrylat und 2-Hydroxypropylmethacrylat besteht, in einem molaren Verhältnis von etwa 1:1 bis etwa 1:1,2 umgesetzt wird.

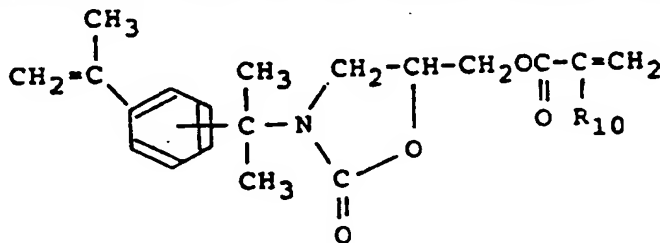
5. Das Verfahren nach Anspruch 3, bei dem die Reaktion bei einer Temperatur von etwa 25 bis etwa 110 °C durchgeführt wird.
6. Das Verfahren nach Anspruch 4, bei dem die Reaktion bei einer Temperatur von etwa 25 bis etwa 110 °C durchgeführt wird.
7. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 3 beansprucht ist, bei dem die Reaktion in Anwesenheit eines Urethanisierung beschleunigenden Katalysators durchgeführt wird.
8. Das Verfahren nach Anspruch 7, bei dem der Urethanisierung beschleunigende Katalysator in einer Menge von etwa 0,1 bis etwa 5 Gew.-%, bezogen auf das Gewicht des Isocyanats, vorhanden ist.
9. Das Verfahren nach Anspruch 7, bei dem der Urethanisierung beschleunigende Katalysator Dibutylzinndilaurat ist.
10. Das Verfahren nach Anspruch 3, bei dem die Reaktion in Anwesenheit eines Lösungsmittels durchgeführt wird.
11. Das Verfahren nach Anspruch 10, bei dem das Lösungsmittel aus der Gruppe ausgewählt ist, die aus Hexan, Benzol und Toluol besteht.
12. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 4 beansprucht ist, bei dem der Reaktionsverfahrensschritt in Anwesenheit eines Urethanisierung beschleunigenden Katalysators durchgeführt wird.
13. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren oder eines der folgenden Formeln (III) und (IV):



wobei R₃ bis R₆ jeweils unabhängig aus der Gruppe ausgewählt sind, die aus Wasserstoff und einer Methylgruppe besteht,

das das Umsetzen von 3-Isopropenyl- α,α -dimethylbenzylisocyanat oder 4-Isopropenyl- α,α -dimethylbenzylisocyanat mit einer Verbindung umfaßt, die aus der Gruppe ausgewählt ist, die aus Glyceroldiacrylat, Glycerolacrylatmethacrylat und Glyceroldimethacrylat besteht.

- 5 14. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 13 beansprucht ist, das das Umsetzen von 3-Isopropenyl- α,α -dimethylbenzylisocyanat oder 4-Isopropenyl- α,α -dimethylbenzylisocyanat mit einer Verbindung, die aus der Gruppe ausgewählt ist, die aus Glyceroldiacrylat, Glycerolacrylatmethacrylat, Glyceroldimethacrylat besteht, in einem molaren Verhältnis von 1:1 - 1,2 umfaßt.
- 10 15. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 13 beansprucht ist, bei dem der Reaktionsverfahrensschritt bei einer Reagens-Temperatur von 25 bis 110 °C durchgeführt wird.
- 15 16. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 14 beansprucht ist, bei dem der Reaktionsverfahrensschritt bei einer Reagens-Temperatur von 25 bis 110 °C durchgeführt wird.
- 20 17. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 13 beansprucht ist, bei dem der Reaktionsverfahrensschritt in Anwesenheit eines Urethanisierung beschleunigenden Katalysators durchgeführt wird.
- 25 18. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 17 beansprucht ist, bei dem der Urethanisierung beschleunigende Katalysator in einer Menge von 0,1 bis 5 Gew.-%, bezogen auf das Gewicht des Isocyanats, vorhanden ist.
- 30 19. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 17 beansprucht ist, bei dem der Urethanisierung beschleunigende Katalysator Dibutylzinndilaurat ist.
- 35 20. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 13 beansprucht ist, bei dem der Reaktionsverfahrensschritt in Anwesenheit eines Lösungsmittels durchgeführt wird.
- 40 21. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 20 beansprucht ist, bei dem das Lösungsmittel aus der Gruppe ausgewählt ist, die aus Hexan, Benzol und Toluol besteht.
- 45 22. Ein Verfahren zum Herstellen eines polyfunktionellen Monomeren, wie es in Anspruch 14 beansprucht ist, bei dem der Reaktionsverfahrensschritt in Anwesenheit eines Urethanisierung beschleunigenden Katalysators durchgeführt wird.
- 50 23. Ein Verfahren zum Herstellen eines difunktionellen Monomeren der folgenden Formel:



worin R₁₀ Wasserstoff oder eine Methylgruppe darstellt,

- 55 das das Umsetzen von 3-Isopropenyl- α,α -dimethylbenzylisocyanat oder 4-Isopropenyl- α,α -dimethylbenzylisocyanat und Glycidylmethacrylat oder Glycidylacrylat in einem Lösungsmittel, das in bezug auf diese Materialien inert ist, in Anwesenheit eines Oxazolidon erzeugenden Reaktionskatalysators umfaßt.

24. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 23 beansprucht ist, bei dem das molare Verhältnis von 3-Isopropenyl- α , α -dimethylbenzylisocyanat oder 4-Isopropenyl- α , α -dimethylbenzylisocyanat zu Glycidylmethacrylat oder Glycidylacrylat 1:0,80 bis 1,20 ist.

25. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 23 beansprucht ist, bei dem der Reaktionsverfahrensschritt bei einer Reagens-Temperatur von 70 bis 150 °C durchgeführt wird.

26. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 24 beansprucht ist, bei dem der Reaktionsverfahrensschritt bei einer Reagens-Temperatur von 70 bis 150 °C durchgeführt wird.

27. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 23 beansprucht ist, bei dem der Oxazolidon erzeugende Reaktionskatalysator in einer Menge von 1,0 bis 10 Mol-% relativ zu dem Isocyanat vorhanden ist.

28. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 23 beansprucht ist, bei dem der Oxazolidon erzeugende Reaktionskatalysator Tributylphosphinoxid-lithiumbromid ist.

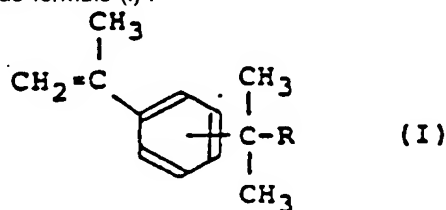
29. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 23 beansprucht ist, bei dem das inerte Lösungsmittel aus der Gruppe ausgewählt ist, die aus Benzol, Toluol und Xylol besteht.

30. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 23 beansprucht ist, das das Umsetzen von 3-Isopropenyl- α , α -dimethylbenzylisocyanat oder 4-Isopropenyl- α , α -dimethylbenzylisocyanat mit Glycidylmethacrylat oder Glycidylacrylat in Anwesenheit eines Oxazolidon erzeugenden Reaktionskatalysators in einer Menge von 1,0 bis 10 Mol-% für 1 Mol des 3-Isopropenyl- α , α -dimethylbenzylisocyanats oder 4-Isopropenyl- α , α -dimethylbenzylisocyanats umfaßt.

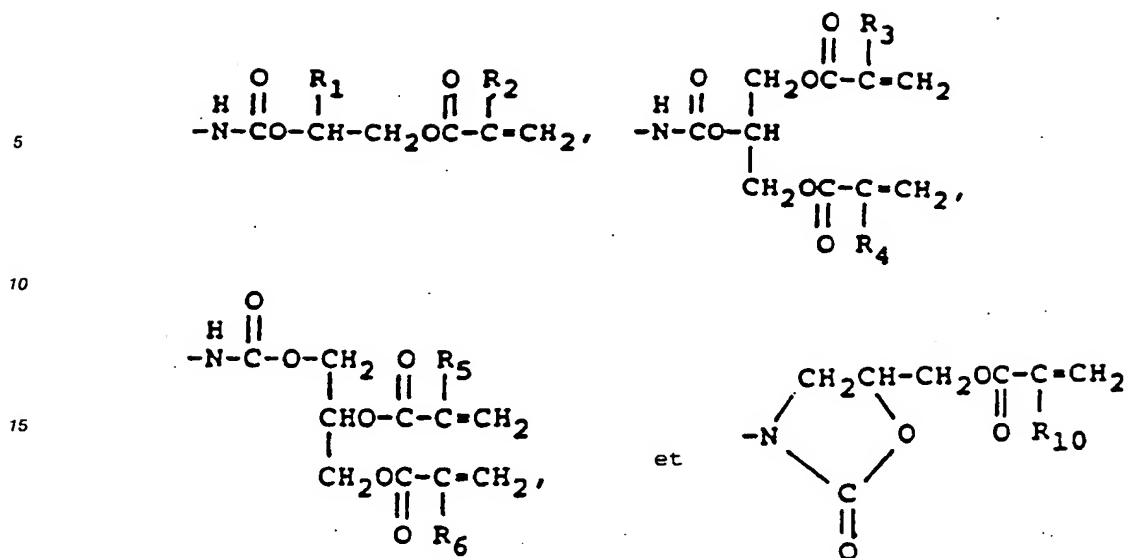
31. Ein Verfahren zum Herstellen eines difunktionellen Monomeren, wie es in Anspruch 30 beansprucht ist, bei dem der Oxazolidon erzeugende Reaktionskatalysator Tributylphosphinoxid-lithiumbromid ist.

Revendications

1. Un monomère polyfonctionnel de formule (I) :

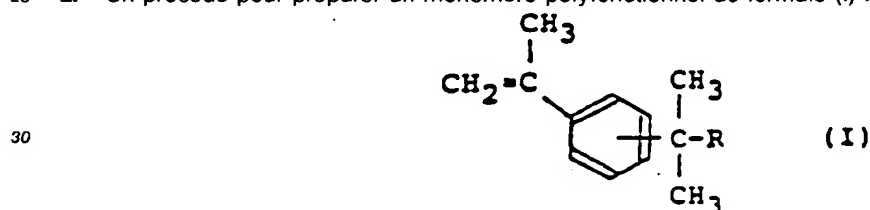


dans laquelle R est choisi dans le groupe constitué de

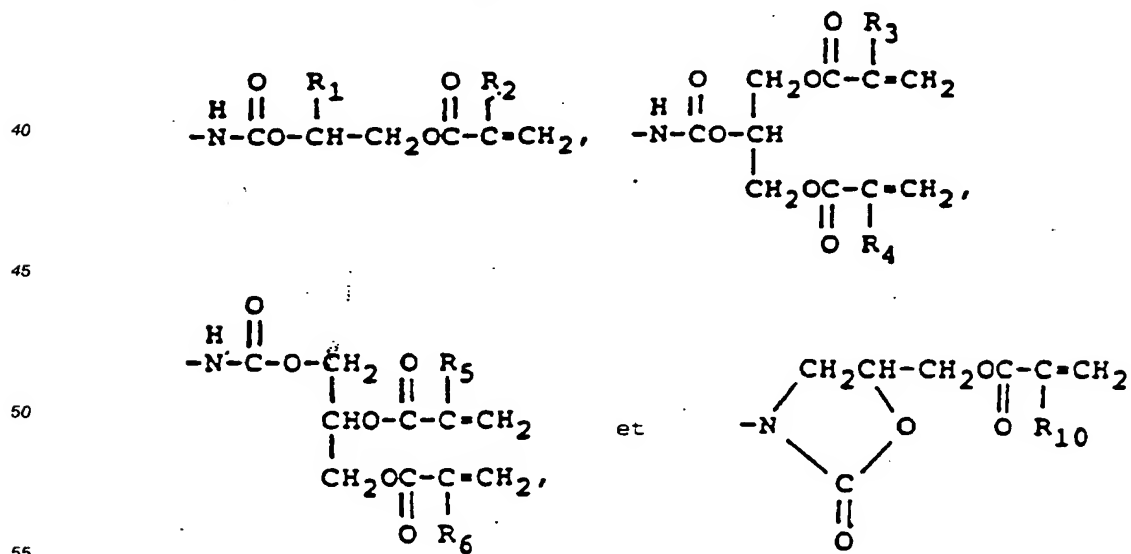


où R_1 à R_{10} sont chacun indépendamment choisis parmi un hydrogène et un groupe méthyle.

25 **2.** Un procédé pour préparer un monomère polyfonctionnel de formule (I) :



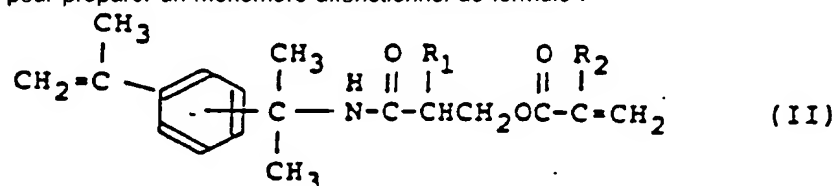
35 dans laquelle R est choisi dans le groupe constitué par



où R_1 à R_{10} sont chacun indépendamment choisis parmi un hydrogène et un groupe méthyle,

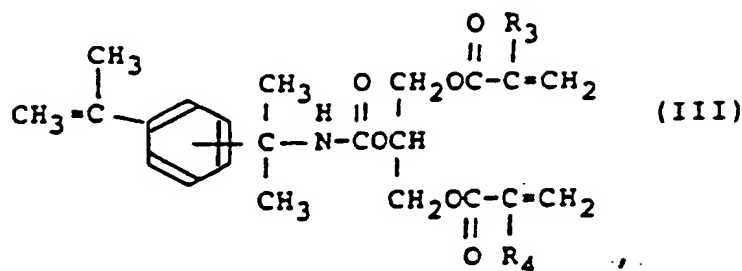
comprenant la réaction d'un composé choisi parmi l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle et de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle avec un composé choisi dans le groupe constitué par l'acrylate de 2-hydroxyéthyle, le méthacrylate de 2-hydroxyéthyle, l'acrylate de 2-hydroxypropyle, le méthacrylate de 2-hydroxypropyle, le diacrylate de glycérol, l'acrylate de glycérol, le diméthacrylate de glycérol, le méthacrylate de glycidyle et l'acrylate de glycidyle.

3. Un procédé pour préparer un monomère difonctionnel de formule :

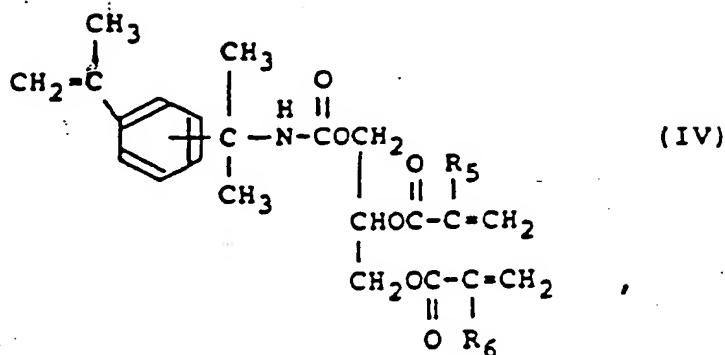


dans laquelle R_1 et R_2 sont chacun indépendamment choisis parmi un hydrogène et un groupe méthyle, comprenant la réaction d'un composé choisi parmi l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle et l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle avec un composé choisi dans le groupe constitué par l'acrylate de 2-hydroxyéthyle, le méthacrylate de 2-hydroxyéthyle, l'acrylate de 2-hydroxypropyle et le méthacrylate de 2-hydroxypropyle.

4. Le procédé de la revendication 3, dans lequel le composé choisi parmi l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle et l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle est mis à réagir avec ledit composé choisi dans le groupe constitué par l'acrylate de 2-hydroxyéthyle, le méthacrylate de 2-hydroxyéthyle, l'acrylate de 2-hydroxypropyle et le méthacrylate de 2-hydroxypropyle dans un rapport molaire d'environ 1/1 à environ 1/1,2.
5. Le procédé de la revendication 3, dans lequel ladite réaction est effectuée à une température d'environ 25 à environ 110°C.
6. Le procédé de la revendication 4, dans lequel ladite réaction est effectuée à une température d'environ 25 à environ 110°C.
7. Un procédé pour préparer un monomère difonctionnel selon la revendication 3, dans lequel ladite réaction est effectuée en présence d'un catalyseur favorisant l'uréthannisation.
8. Le procédé selon la revendication 7, dans lequel ledit catalyseur favorisant l'uréthannisation est présent en une proportion d'environ 0,1 à environ 5 % en poids relativement au poids de l'isocyanate.
9. Le procédé de la revendication 7, dans lequel ledit catalyseur favorisant l'uréthannisation est le dilaurate de dibutylétain.
10. Le procédé selon la revendication 3, dans lequel ladite réaction est effectuée en présence d'un solvant.
11. Le procédé selon la revendication 10, dans lequel ledit solvant est choisi parmi l'hexane, le benzène et le toluène.
12. Un procédé pour préparer un monomère difonctionnel selon la revendication 4, dans lequel ladite étape de réaction est effectuée en présence d'un catalyseur favorisant l'uréthannisation.
13. Un procédé pour préparer d'un monomère polyfonctionnel répondant à l'une des formules (III), (IV) et (V) suivantes :



et



dans lesquelles R_3 à R_6 sont chacun choisis indépendamment parmi un hydrogène et un groupe méthyle,

comprenant la réaction de l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle ou de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle avec un composé choisi parmi le groupe constitué par le diacrylate de glycérol, l'acrylate-méthacrylate de glycérol et le diméthacrylate de glycérol.

14. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 13, comprenant la réaction de l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle ou de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle avec un composé choisi dans le groupe constitué par le diacrylate de glycérol, l'acrylate-méthacrylate de glycérol et le diméthacrylate de glycérol dans un rapport molaire de 1/1 - 1,2.

15. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 13, dans lequel ladite étape de réaction est effectuée à une température des composés réagissants de 25 à 110°C.

16. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 14, dans lequel ladite étape de réaction est effectuée à une température des composés réagissants de 25 à 110°C.

17. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 13, dans lequel ladite étape de réaction est effectuée en présence d'un catalyseur favorisant l'uréthannisation.

18. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 17, dans lequel ledit catalyseur favorisant l'uréthannisation est présent en une proportion de 0,1 à 5 % en poids relativement au poids de l'isocyanate.

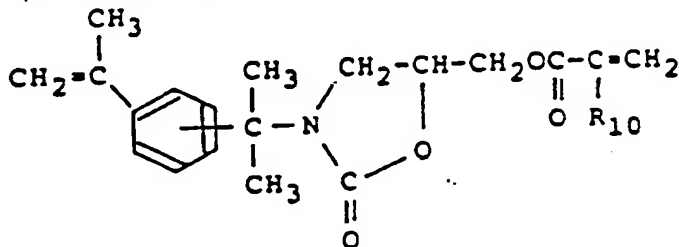
19. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 17, dans lequel ledit catalyseur favorisant l'uréthannisation est le dilaurate de dibutylétain.

20. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 13, dans lequel ladite étape de réaction est effectuée en présence d'un solvant.

21. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 20, dans lequel ledit solvant est choisi parmi l'hexane, le benzène et le toluène.

22. Un procédé pour préparer un monomère polyfonctionnel selon la revendication 14, dans lequel ladite étape de réaction est effectuée en présence d'un catalyseur favorisant l'uréthannisation.

23. Un procédé pour préparer un monomère difonctionnel de formule suivante :



dans laquelle R_{10} représente un hydrogène ou un groupe méthyle, comprenant la réaction de l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle ou de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle et du méthacrylate de glycidyle ou de l'acrylate de glycidyle dans un solvant qui est inerte relativement à ces matières, en présence d'un catalyseur de réaction produisant une oxazolidone.

24. Un procédé pour préparer un monomère difonctionnel selon la revendication 23, dans lequel le rapport molaire de l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle ou de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle au méthacrylate de glycidyle ou à l'acrylate de glycidyle est de 1/0,80 à 1,20.

25. Un procédé pour préparer un monomère difonctionnel selon la revendication 23, dans lequel ladite étape de réaction est effectuée à une température des composés réagissants de 70 à 150 °C.

26. Un procédé pour préparer un monomère difonctionnel selon la revendication 24, dans lequel ladite étape de réaction est effectuée à une température des composés réagissants de 70 à 150 °C.

27. Un procédé pour préparer un monomère difonctionnel selon la revendication 23, dans lequel ledit catalyseur de réaction produisant une oxazolidone est présent en une proportion de 1,0 à 10 % molaires relativement à l'isocyanate.

28. Un procédé pour préparer un monomère difonctionnel selon la revendication 23, dans lequel ledit catalyseur de réaction produisant une oxazolidone est l'oxyde de tributylphosphine-bromure de lithium.

29. Un procédé pour préparer un monomère difonctionnel selon la revendication 23, dans lequel ledit solvant inerte est choisi parmi le benzène, le toluène et le xylène.

30. Un procédé pour préparer un monomère difonctionnel selon la revendication 23, comprenant la réaction de l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle ou de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle avec le méthacrylate de glycidyle ou l'acrylate de glycidyle en présence d'un catalyseur de réaction produisant une oxazolidone en une proportion de 1,0 à 10 % molaires pour une mole de l'isocyanate de 3-isopropényl- α,α -diméthylbenzyle ou de l'isocyanate de 4-isopropényl- α,α -diméthylbenzyle.

31. Un procédé pour préparer un monomère difonctionnel selon la revendication 30, dans lequel ledit catalyseur de réaction produisant une oxazolidone est l'oxyde de tributylphosphine-bromure de lithium.